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Workers Compensation Fund

Ergonomics:

Assessing the Risk Factors

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Good Communication is Important

Getting Robbed.mpeg

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Course Expectations

- Definitions and History of Ergonomics
- The Regulatory Environment
- Introduction to Risk Assessment
- Anthropometry
- Ergonomic Risk Factors
- Assessing Risk Using Peer Reviewed Tools
- Job Assessment
- Finding Solutions

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Definitions of Ergonomics

OSHA

- "Ergonomics is the science of fitting jobs to people. Ergonomics encompasses the body of knowledge about physical abilities and limitations as well as other human characteristics that are relevant to job design. Ergonomic design is the application of this body of knowledge to the design of the workplace for safe and efficient use by workers."

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Another Definition

- Ergonomics is a discipline aimed at removing barriers to quality, productivity, and safe human performance, by fitting systems, equipment, products, tasks, jobs and environments to people.

(Ergoweb 2001)

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Ergonomic Terms

- Work Related Musculoskeletal Disorder (WMSD) : Injuries to muscles, tendons and others tissues arising out of exposure to risk factors in the workplace, usually chronic in nature.
- Risk Factor: Actions or conditions in the workplace that might produce injuries to workers such as forceful exertion, repetition, awkward postures, vibration, duration and others.
- Personal Risk Factors: Individual health conditions that might have an effect on an individuals response to workplace risk factors. These include age, gender, body mass index and others.
- Job Factors: Actual workstation conditions, work activities, work organization, tools used, work methods and environmental conditions.

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Ergonomic Terms

- Recovery Time: Time between worker exertions at the end of one task/work cycle and the beginning of another.
- Repetitive Motion Injury (RMI): A WMSD caused by a repetitive job, task or operation.

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A New Problem?

"The maladies that afflict the clerks arise from three causes: First, constant sitting, secondly the incessant movement of the hand and always in the same direction, thirdly, the strain on the mind from the effort not to disfigure the books by errors or cause loss to their employers…furthermore incessant driving of the pen over paper causes intense fatigue of the hand and the whole arm because of the continuous…strain on the muscles and tendons which results…in the failure of power in the right hand."

Bernardino Ramazinni, *Diseases of Workers*, 1713

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Ergonomics = Productivity

- Fredric Taylor: Father of "Scientific Management" in the early 1900's used more effective job design techniques, tools and measurements to increase productivity in the steel industry.
- Henry Ford: Pioneer in mass production techniques championed the idea of "bringing the work to the worker" minimizing unnecessary motions, and matching the workers most productive positions and postures to the job.
- World War II: Stimulated the advancement of anthropometry (precise measurements of average length of human body segments) and research on muscle forces required to complete tasks, stresses on the low back when lifting, cardiovascular response to heavy physical activity and cognitive ergonomics.

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Ergonomics Fits in with Most Business Goals

- To increase revenues and profits
- To avoid negative economic consequences and/or publicity
- To "do the right thing"

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How Serious is the Problem?

- 435,180 WMSDs reported in 2003
- Averaged 10 days away from work compared to 8 days for other lost time injuries
- WMSDs comprise one third of all work related injuries resulting in lost time

Source: National Safety Council Injury Facts 2005-2006 edition

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How Serious is the Problem?

2007 BLS Data:

- 448,380 workplace injury cases involving Strains, Sprains, & Tears (2007)
- 235,960 workplace injury cases involving injuries to the Back (2007)

Source www.bls.gov

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Regulatory Environment

- 1970 OSH Act -General Duty Clause: Section 5(a)(1)
- Cal-OSHA Title VII-5110
  - Work related causation
  - Repetitive Motion as related to the workplace
  - Medical Requirements
- OSHA 1910.900 (Repealed)
- Washington State Ergo Standard (Repealed)

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What's Next?

- Significant professional and political differences remain over causation and legitimacy
- Obama Administration may refocus efforts on ergonomics standard
- Expect litigation
- Adopting a "best practice" approach is recommended

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Introduction to Risk Assessment

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Three Rules of Risk Assessment

- Never bet a lot to gain a little
- Never bet more than you can afford to lose
- Consider the odds

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Risk Assessment Matrix

Policyholder: _____

Job Description: _____

_____

_____

_____

Number of Workers Exposed: _____

Hazard Severity	Hazard Probability			
	Likely	Probable	Possible	Unlikely
May Cause Death, Loss of Facility $100,000+	1	1	2	3
May Cause Severe Injury, Illness or Property Loss $50-99,000	1	2	3	4
May Cause Minor Injury, Illness or Property Loss $1000 -49,000	2	3	4	5
Presents Minimal Injury, Illness or Property Loss	3	4	5	5

Risk Assessment Code: 1. Critical 2. Serious 3. Moderate 4. Minor 5. Negligible

Recommendation: _____

_____

_____

_____

Date: _____ Consultant: _____

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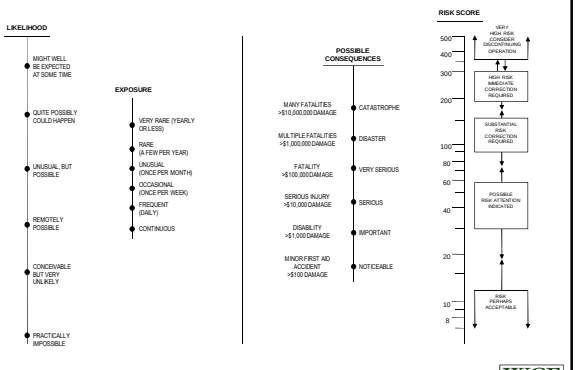

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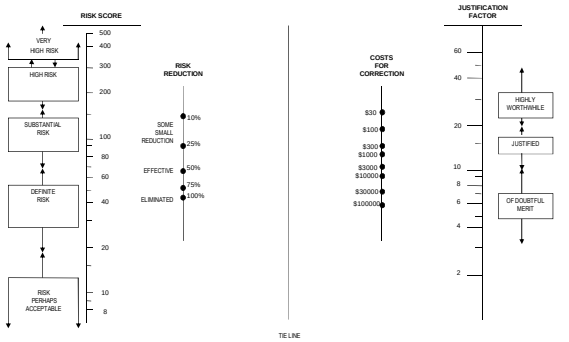

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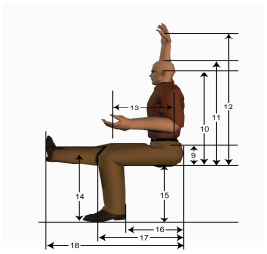
Anthropometry

- "The study of human physical dimensions such as height, shoulder width, and distance between anatomical points. This information defines human limits in terms of body dimensions for optimum fit to the work environment."



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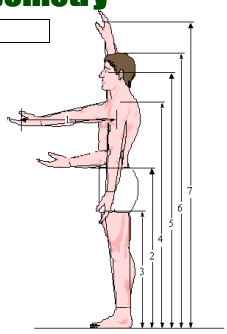
Anthropometry

	Percentile			
	Male		Female	
Measurement	95	5	95	5
1.Forward Reach	36.9	34.0	35.1	32.2
2.Elbow Height	44.6	39.5	41.5	36.1
3.Knuckle Height	31.8	27.2	29.6	24.8
4.Shoulder Height	59.1	53.2	55.8	49.8
5.Eye Height	68.4	60.9	63.7	56.8
6.Stature	73.2	66.4	67.7	59.5
7.Overhead Reach	84.8	73.2	78.8	69.2



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Why is this Important?

- Basic part of the data behind most of the risk assessment models that attempt to quantify exposure
- Values become important within the models in evaluation of "load moments" on different parts of the body under stress
- Differences in human capabilities must be taken into consideration for good ergonomic design and are often the source of ergonomic problems

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Ergonomic Risk Factors

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Work Related Factors

- Force
- Repetition
- Duration
- Posture
- Recovery Time
- Vibration
- Metabolic Issues
- Temperature
- Psychosocial Risk Factors
- Personal Risk Factors

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Force

The effect of an exertion on internal body tissues or the characteristics of an object external to the body.

- the weight of an object to be lifted
- the muscle contraction needed to sustain or hold a posture
- the exertion needed to begin pushing a load on casters
- the force needed to grasp and operate a power tool
- the strength of a pinch grip needed in fine assembly operations
- Generally: the greater the forces required, the greater the risk of injury

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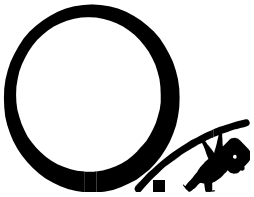
Load Moments

Moment = force X distance



"Give me a lever long enough and a fulcrum on which to place it, and I shall move the world." Archimedes (~287–212 BC).

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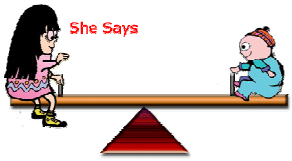
Kindergarten Physics

"All I ever needed to know I learned in kindergarten."

--Robert Fulghum



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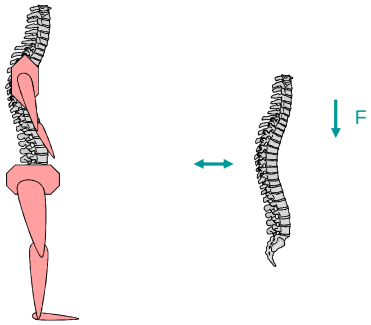
Kindergarten Physics



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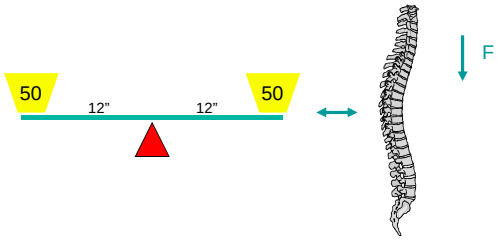

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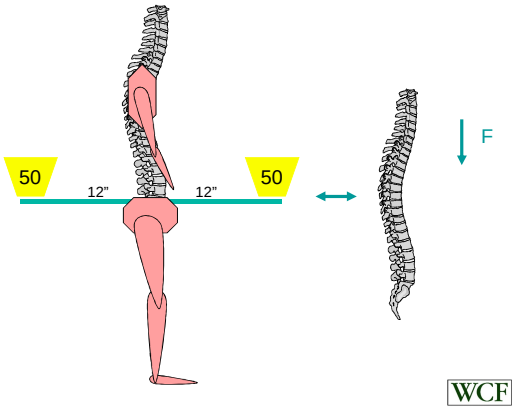

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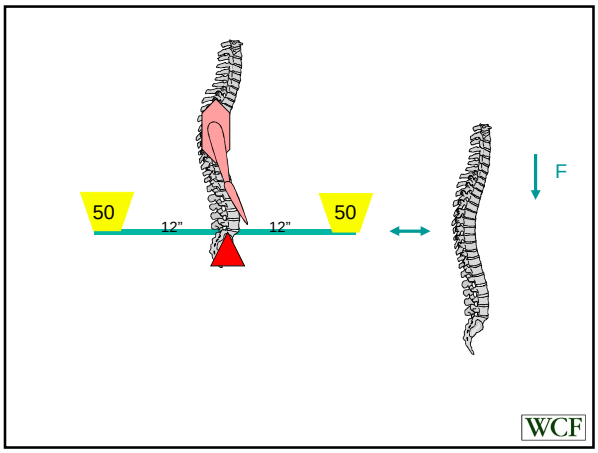
50
12"
12"
50
F
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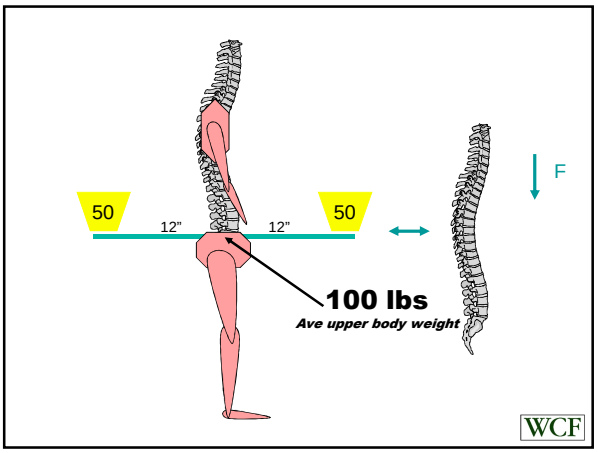
50
12"
12"
50
F
100 lbs
Ave upper body weight
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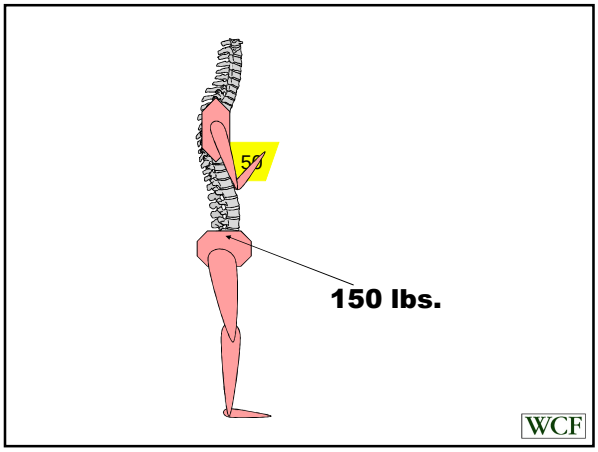
50
150 lbs.
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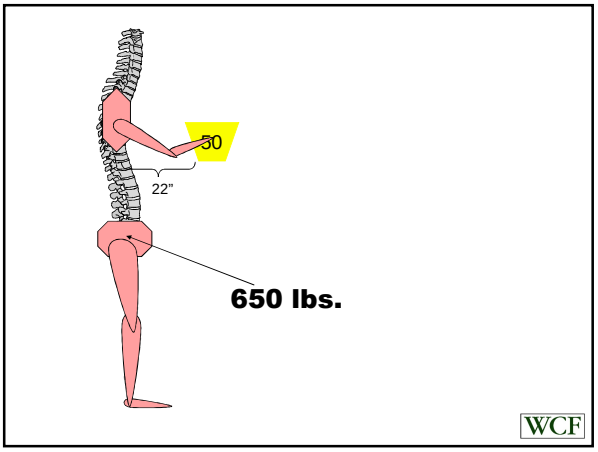
50
22"
650 lbs.
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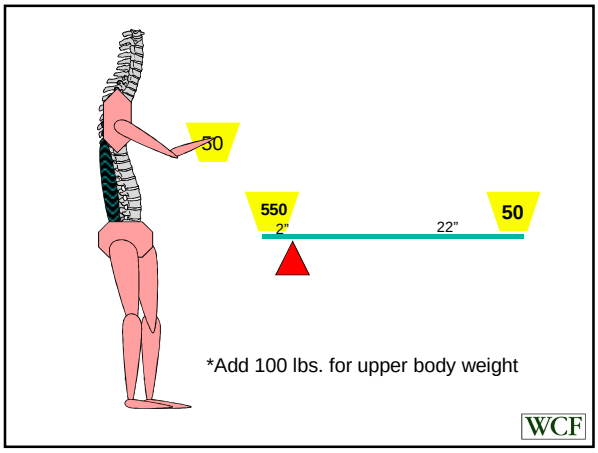
50
550
2"
22"
50
*Add 100 lbs. for upper body weight
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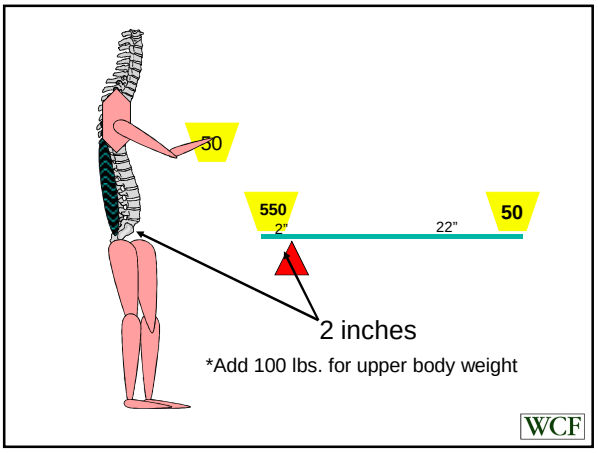
50
550
2"
22"
50
2 inches
*Add 100 lbs. for upper body weight
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Back Compressive Forces Estimate

Fc = 3(BW)cosΦ + 0.5(L x HD) = 0.8 [(BW)/2 + L]

Where:
- **BW = Body Weight**
- **L = Load**
- **HD = Horizontal Distance from Hands to Low Back**
- **Φ = Torso Angle with Horizontal**

This is just an estimate!

More precise estimations can be made using computer models such as the University of Michigan computer model.

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What did we learn in kindergarten about this position?

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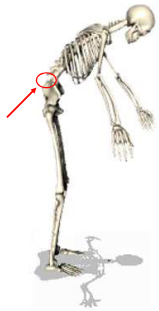
Fulcrum of improper lifting becomes the L5/S1 area of the spine and associated muscles, ligaments & disc.



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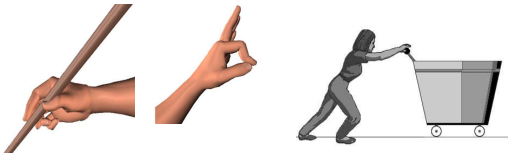
- **Whenever we use a body segment to lift or maneuver something a "moment" is created**



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Posture

- The position of the body while performing tasks
- Deviation from neutral postures is associated with greater risk of injury
- When combined with other risk factors, especially force, injury potential is greater
- Force is a component of posture
- Force required to do task is greater when body is out of "neutral posture"

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Postural Problems

- Wrist flexion and extension have been associated with Carpal Tunnel Syndrome

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Postural Problems

- Ulnar deviation of the wrist of greater than 20 degrees has been associated with injury

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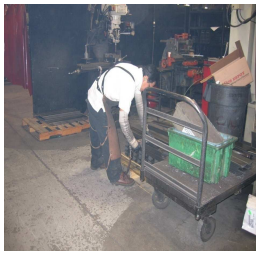
Postural Problems

- Working with hands above shoulder height for extended periods of time has been associated with injury

Postural Problems

- Poor spinal posture is associated with injury



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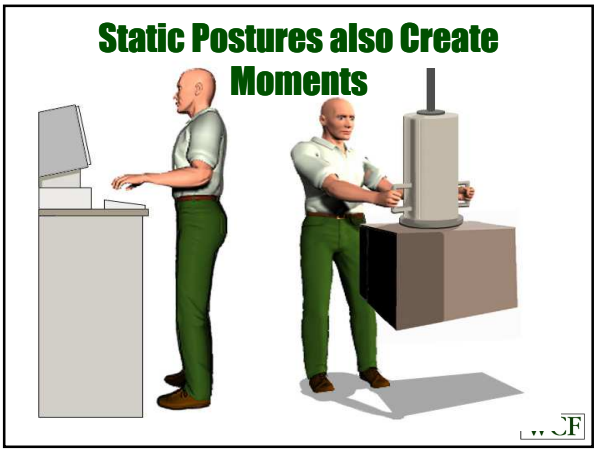
Static Postures also Create Moments

Static Postures

- Since all body parts have weight, the forces required to maintain a static posture can also contribute to muscle strain/sprain.
- Example: How big is your head?
  - What is the average range for the weight of the human head?
  - Compare this to the weight range for a bowling ball.
  - What forces are required to keep our heads erect?

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Static Postures

- How do the discs in the low back receive nutrients and fluids?
  - Blood supply is available while young but limited
  - Inhibition, not blood supply, is primary way discs receive nutrients after ~age 18.
  - Movement of body/muscles is primary way to supply nutrients to discs.
  - When maintaining static postures daily for extended periods of time, the ability for lymphatic system and musculature to move fluids is greatly decreased.

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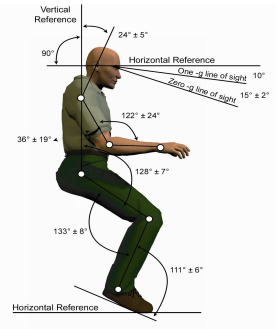
Neutral Postures Pose Least Stress



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Repetition:

- Time quantification of a similar task/exertion performed during a job such as de-palletizing 40 pound boxes 4 times a minute
- Cycle – a repeated set of motions or elements of a task (example above 1 box/15 sec).
- Repetitive – tasks are considered repetitive if they have cycle times of 30 sec or less (Armstrong et al., 1984)

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Duration

- The length of time each day/shift the worker performs the job such as 4 hours in the morning and 4 hours in the afternoon
- Generally, the greater the number of repetitions and the longer the duration the greater the risk of injury

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Recovery Time

- Brief rest periods can reduce discomfort and fatigue
- Recovery time should be increased as the duration and extent of risk factors increase
- Needed recovery time will vary greatly with the task and the worker

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Vibration

- Whole body or segmental vibration can increase the risk of injury alone or when associated with other risk factors
- Vibration may affect blood flow to tissues and increase risk
- Examples: Power hand tool operators and heavy equipment operators

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Metabolic Issues

- Metabolism is the biological process whereby the body turns food and oxygen into energy by which the muscles contract and produce work
- As the rate of activity/demand on the muscles increases so does the demand for energy
- The body's response is increased breathing and heart rate
- If a person's capacity is exceeded metabolic waste products build up fatigue ensues
- Physical fatigue can affect a workers safety, productivity and accuracy

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Temperature

- Low Temp =
  - Decreased blood flow
  - Increased effort
  - Low Temp and Vibration are synergistic in their affects
  - Greater force may be exerted to complete the task (use of gloves for warmth and protection will also increase the force exerted)
- High Temp =
  - Heat exhaustion
  - Metabolic issues

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Psychosocial Risk Factors

- Boredom, task invariability
- Mental overload or the opposite
- Work organization, role clarity, work pacing, shift and overtime
- Social support from other workers and management
- Change, technology advances, layoffs
- These associations are not clear

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Personal Risk Factors

- Age: maximum incidence between 35-55 years of age
- Gender: Upper extremity WMSDs (UEWMSD) may be higher in females
- Fitness: Low back pain and certain UEWMSDs are impacted by obesity
- Health: Diabetes, pregnancy and arthritis may be connected with higher incidence
- There is broad, but not universal agreement on these factors

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Break

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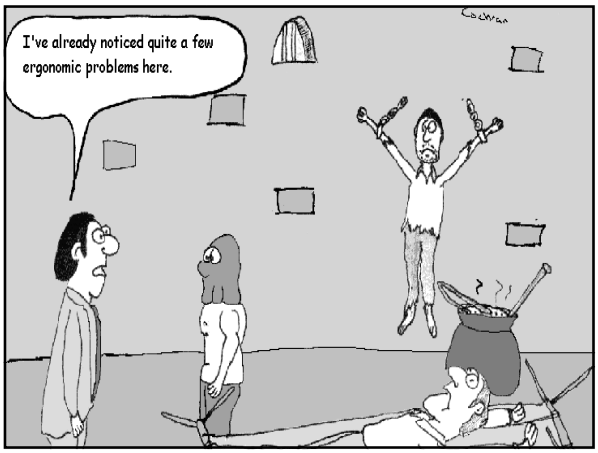

Peer Reviewed Risk Assessment Tools

- Introduce a degree of standardization in assessing risk factors
- Undergo academic debate, use testing, modification
- More professional than "opinion" alone
- Bring rigorous research to the workplace
- Allow the quantification of risk to produce better risk management and investment decisions
- They truly represent "best practice'

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Limitations

- Almost all are designed for mono tasks which doesn't describe most jobs
- Most do not assess all risk factors
- Best Practice requires that multiple tools be used in combination for best results
- Some are time consuming and difficult for end users to learn

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Available Tools

- NIOSH Revised Lifting Equation (low back)
- ACGIH Hand Activity Level (HAL)
- Moore-Garg Strain Index
- Rapid Upper Limb Assessment (RULA)
- Rapid Entire Body Assessment (REBA)
- Washington State Lifting Calculator
- Utah 2D Biomechanical Lifting Model
- Liberty Mutual (Snook)Tables for Lifting/Lowering
- ACGIH Lifting Model
- Utah Simplified Shoulder Moment Estimation

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Using Peer Reviewed Ergo Tools

We will do study and/or practice with 5 tools for hand/wrist and low back injury prevention.

- ACGIH Hand Activity Level
- Moore-Garg Strain Index
- RULA (Rapid Upper Limb Assessment)
- Washington State Lifting Model
- NIOSH revised Lifting Equation

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ACGIH Hand Activity Level (HAL)

- Developed by the same organization that publishes chemical exposure limits (TLV's) – Industrial Hygienists
- Dr. Tom Armstrong of Univ. of Michigan heavily involved (Chair of ANSI Z365 Committee)
- Simple in use but limited in risk factors considered
- Seems to have credibility with OSHA/NIOSH
- Easy to train people to use it

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ACGIH® TLV® for Hand Activity

Job	Analyst	Date
	Left	Right
Hand Activity Level (HAL) (See scale below)		
Normalized Peak Force (NPF) (See table below)		
Ratio = NPF / (10-HAL)		
Determine Result TLV = 0.78 AL = 0.56	> TLV ☐ AL to TLV ☐ < AL ☐	> TLV ☐ AL to TLV ☐ < AL ☐

Hand Activity Level Rating

0	2	4	6	8	10
Hands idle most of the time; no regular exertions	Consistent conspicuous long pauses; or very slow motions	Slow steady motion/exertions; frequent brief pauses	Steady motion/ exertion; infrequent pauses	Rapid steady motion/exertions; no regular pauses	Rapid steady motion/ difficulty keeping up or continuous exertion

Estimation of Normalized Peak Force for Hand Forces

%MVC	*Subjective Scale* Score	Verbal Anchor	*Moore-Garg Observer Scale* (Alternative Method)	*NPF*
0	0	Nothing at all		0
5	0.5	Extremely Weak (Just Noticeable)	Barely Noticeable or Relaxed Effort	0.5
10	1	Very Weak		1
20	2	Weak (Light)	Noticeable or Definite Effort	2
30	3	Moderate		3
40	4		Obvious Effort, But Unchanged Facial Expression	4
50	5	Strong (Heavy)		5
60	6		Substantial Effort with Changed Facial	6
70	7	Very Strong	Expression	7
80	8			8
90	9		Uses Shoulder or Trunk for Force	9
100	10	Extremely Strong (almost maximum)		10

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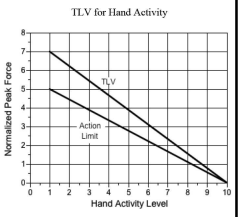

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ACGIH® TLV® for Hand Activity

Job	Analyst	Date
	Left	Right
Hand Activity Level (HAL) (See scale below)	4	1
Normalized Peak Force (NPF) (See table below)	1	1
Ratio = NPF / (10-HAL)	1/(10-4) = 0.17	1/(10-1)= 0.11
Determine Result TLV = 0.78 AL = 0.56	> TLV ☐ AL to TLV ☐ < AL ☒	> TLV ☐ AL to TLV ☐ < AL ☒

Hand Activity Level Rating

0	2	4	6	8	10
Hands idle most of the time; no regular exertions	Consistent conspicuous long pauses; or very slow motions	Slow steady motion/exertions; frequent brief pauses	Steady motion/ exertion; infrequent pauses	Rapid steady motion/exertions; no regular pauses	Rapid steady motion/ difficulty keeping up or continuous exertion

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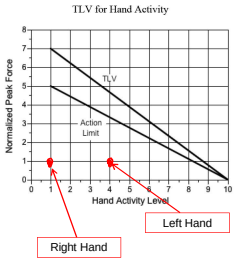

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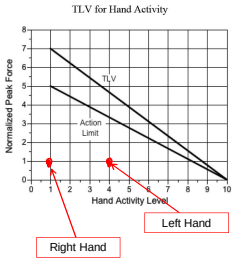
What risk factors are not considered by this tool?



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Moore-Garg Strain Index

- Developed by Arun Garg and Steven Moore (1995)
- Looks at six different risk factors for hand/wrist injuries
- Observational – doesn't interfere with worker
- Gaining in credibility- used in ongoing studies
- Fairly easy to train observers in it's use

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Moore-Garg Strain Index

Task	Analyst
	Date / /

Strain Index	Final rating for each risk factor and multiply them together	SI < 3: Safe SI between 3 and 5: Uncertain SI between 5 and 7: Some Risk SI >7: Hazardous		
Risk Factor	Rating Criterion	Observation	Ratings	Left	Right
Intensity of Exertion [Borg Scale values in brackets]	Light	Barely noticeable or relaxed effort [0-2]	1		
	Somewhat Hard	Noticeable or definite effort [3]	3		
	Hard	Obvious effort; Unchanged expression [4-5]	6		
	Very Hard	Substantial effort; Changed expression [6-7]	9		
	Near Maximal	Uses shoulder or trunk for force [8-10]	13		
Duration of Exertion (% of Cycle)	< 10%		0.5		
	10-29%		1.0		
	30-49%		1.5		
	50-79%		2.0		
	> 80%		3.0		
Efforts Per Minute	< 4		0.5		
	4 - 8		1.0		
	9 - 14		1.5		
	15 - 19		2.0		
	> 20		3.0		
Hand/ Wrist Posture	Very Good	Perfectly Neutral	1.0		
	Good	Near Neutral	1.0		
	Fair	Non-Neutral	1.5		
	Bad	Marked Deviation	2.0		
	Very Bad	Near Extreme	3.0		
Speed of Work	Very Slow	Extremely relaxed pace	1.0		
	Slow	Taking one's own time	1.0		
	Fair	Normal speed of motion	1.0		
	Fast	Rushed, but able to keep up	1.5		
	Very Fast	Rushed and barely/unable to keep up	2.0		
Duration of Task Per Day (hours)	<1		0.25		
	1 - 2		0.50		
	2 - 4		0.75		
	4 - 8		1.00		
	> 8		1.50		

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plastics_mfg_placing_lids.wmv

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Moore-Garg Strain Index

Task	Analyst
Placing Plastic Lids	KHC
	Date: 10/ 14 /09

Strain Index	Final rating for each risk factor and multiply them together	SI < 3: Safe SI between 3 and 5: Uncertain SI between 5 and 7: Some Risk SI > 7: Hazardous		2.25	2.25
Risk Factor	**Rating Criterion**	**Observation**	**Ratings**	**Left**	**Right**
Intensity of Exertion [Borg Scale values in brackets]	Light	Barely noticeable or relaxed effort [0-2]	1	1	1
	Somewhat Hard	Noticeable or definite effort [3]	3		
	Hard	Obvious effort; Unchanged expression [4-5]	6		
	Very Hard	Substantial effort; Changed expression [6-7]	9		
	Near Maximal	Uses shoulder or trunk for force [8-10]	13		
Duration of Exertion (% of Cycle)	< 10%		0.5	1	3
	10-29%		1.0		
	30-49%		1.5		
	50-79%		2.0		
	> 80%		3.0		
Efforts Per Minute	< 4		0.5	1.5	0.5
	4 - 8		1.0		
	9 - 14		1.5		
	15 - 19		2.0		
	> 20		3.0		
Hand/ Wrist Posture	Very Good	Perfectly Neutral	1.0	1.5	1.5
	Good	Near Neutral	1.0		
	Fair	Non-Neutral	1.5		
	Bad	Marked Deviation	2.0		
	Very Bad	Near Extreme	3.0		
Speed of Work	Very Slow	Extremely relaxed pace	1.0	1	1
	Slow	Taking one's own time	1.0		
	Fair	Normal speed of motion	1.0		
	Fast	Rushed, but able to keep up	1.5		
	Very Fast	Rushed and barely/unable to keep up	2.0		
Duration of Task Per Day (hours)	< 1		0.25	1	1
	1 - 2		0.50		
	2 - 4		0.75		
	4 - 8		1.00		
	> 8		1.50		

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University of South Florida Strain Index Excel Worksheet

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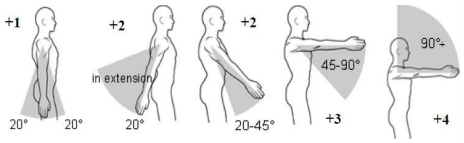
RULA (Rapid Upper Limb Assessment)

- Developed by Dr. Lynn McAtamney and Professor E. Nigel Corlett at University of Nottingham in England
- Gives a quick and systematic assessment of the postural risks to a worker



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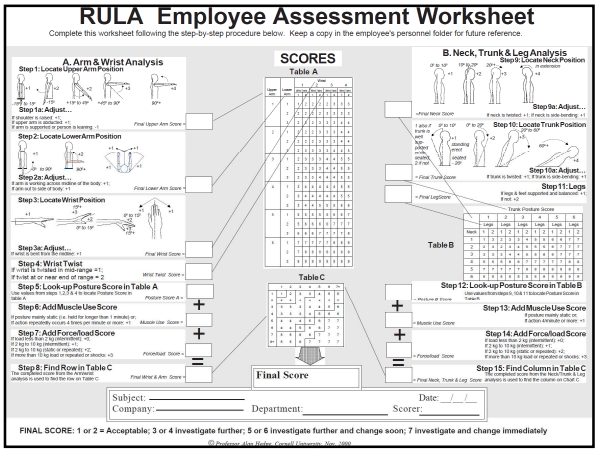

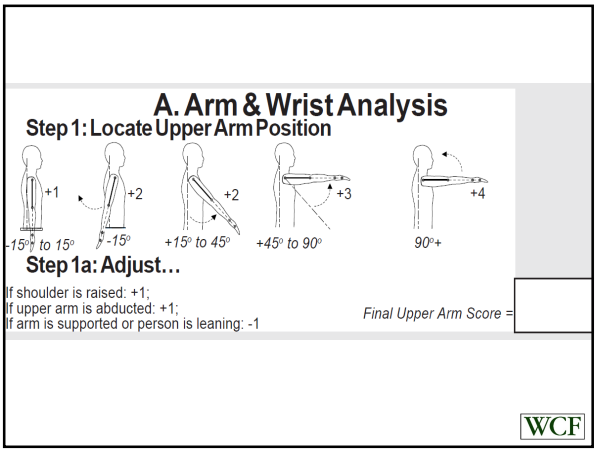

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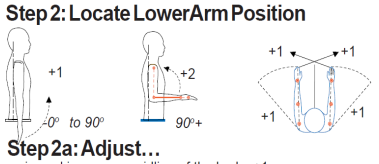
Step 2: Locate Lower Arm Position



Step 2a: Adjust…

If arm is working across midline of the body: +1;
If arm out to side of body: +1

Final Lower Arm Score = ☐

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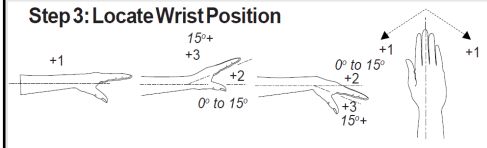
Step 3: Locate Wrist Position



Step 3a: Adjust…

If wrist is bent from the midline: +1

Final Wrist Score = ☐

Step 4: Wrist Twist

If wrist is twisted in mid-range =1;
If twist at or near end of range = 2

Wrist Twist Score = ☐

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Step 5: Look-up Posture Score in Table A

Use values from steps 1,2,3 & 4 to locate Posture Score in table A

Posture Score A = ☐ +

Step 6: Add Muscle Use Score

If posture mainly static (i.e. held for longer than 1 minute) or;
If action repeatedly occurs 4 times per minute or more: +1

Muscle Use Score = ☐ +

Step 7: Add Force/load Score

If load less than 2 kg (intermittent): +0;
If 2 kg to 10 kg (intermittent): +1;
If 2 kg to 10 kg (static or repeated): +2;
If more than 10 kg load or repeated or shocks: +3

Force/load Score = ☐ =

Step 8: Find Row in Table C

The completed score from the Arm/wrist analysis is used to find the row on Table C

Final Wrist & Arm Score = ☐

Table C

	1	2	3	4	5	6	7+
1	1	2	3	3	4	5	5
2	2	2	3	4	4	5	5
3	3	3	3	4	4	5	6
4	3	3	3	4	5	6	6
5	4	4	4	5	6	7	7
6	4	4	5	6	6	7	7
7	5	5	6	6	7	7	7
8+	5	5	6	7	7	7	7

Table A

Upper Arm	Lower Arm	Wrist 1 Wrist Twist 1	1 2	2 1	2 2	3 1	3 2	4 1	4 2
1	1	1	2	2	2	3	3	3	3
	2	2	2	2	2	3	3	3	3
	3	2	3	2	3	3	3	4	4
2	1	2	2	2	3	3	3	4	4
	2	2	2	2	3	3	3	4	4
	3	2	3	3	3	3	4	4	5
3	1	2	3	3	3	4	4	5	5
	2	2	3	3	3	4	4	5	5
	3	2	3	3	4	4	4	5	5
4	1	3	4	4	4	4	4	5	5
	2	3	4	4	4	4	4	5	5
	3	3	4	4	5	5	5	6	6
5	1	5	5	5	5	5	6	6	7
	2	5	6	6	6	6	7	7	7
	3	6	6	6	7	7	7	7	8
6	1	7	7	7	7	7	8	8	9
	2	7	8	8	8	8	9	9	9
	3	9	9	9	9	9	9	9	9

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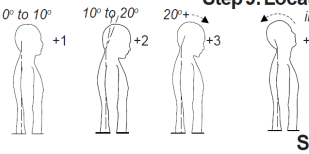
B. Neck, Trunk & Leg Analysis

Step 9: Locate Neck Position



☐ *=Final Neck Score*

Step 9a: Adjust…

If neck is twisted: +1; If neck is side-bending: +1

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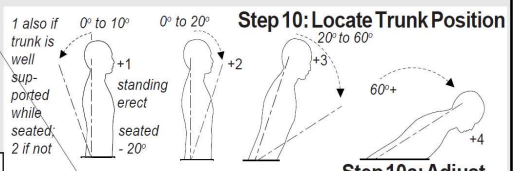
Step 10: Locate Trunk Position



☐ *= Final Trunk Score*

Step 10a: Adjust…

If trunk is twisted: +1; If trunk is side-bending: +1

Step 11: Legs

☐ *= Final LegScore*

If legs & feet supported and balanced: +1;
If not: +2

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Table B

Trunk Posture Score

Neck	1 Legs 1	1 Legs 2	2 Legs 1	2 Legs 2	3 Legs 1	3 Legs 2	4 Legs 1	4 Legs 2	5 Legs 1	5 Legs 2	6 Legs 1	6 Legs 2
1	1	3	2	3	3	4	5	5	6	6	7	7
2	2	3	2	3	4	5	5	5	6	7	7	7
3	3	3	3	4	4	5	5	6	6	7	7	7
4	5	5	5	6	6	7	7	7	7	7	8	8
5	7	7	7	7	7	8	8	8	8	8	8	8
6	8	8	8	8	8	8	8	9	9	9	9	9

Step 12: Look-up Posture Score in Table B

Use values from steps 9, 10 & 11 to locate Posture Score in Table B

☐ *= Posture B Score*

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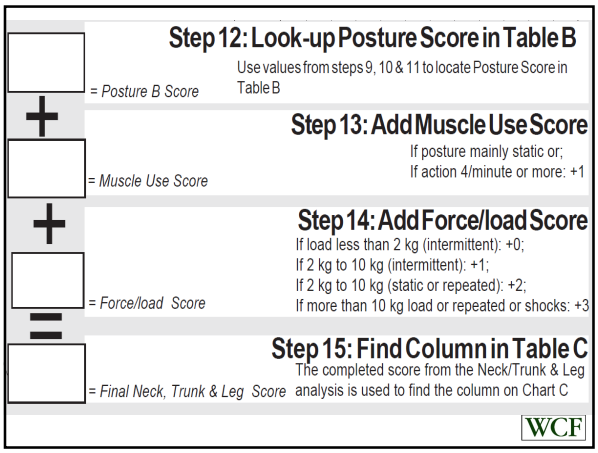

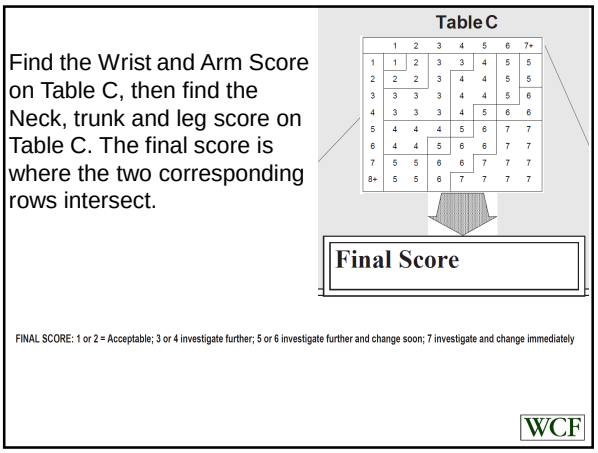

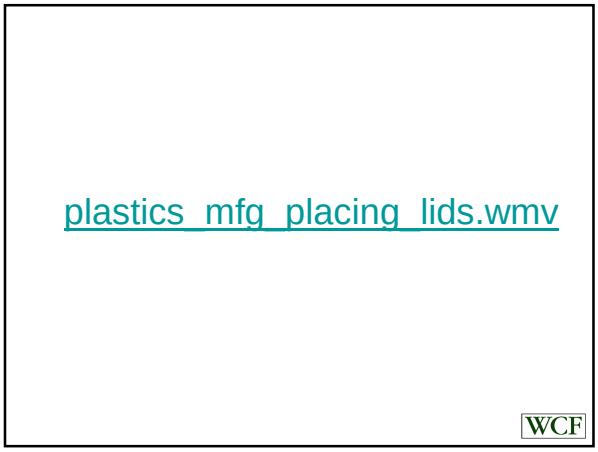

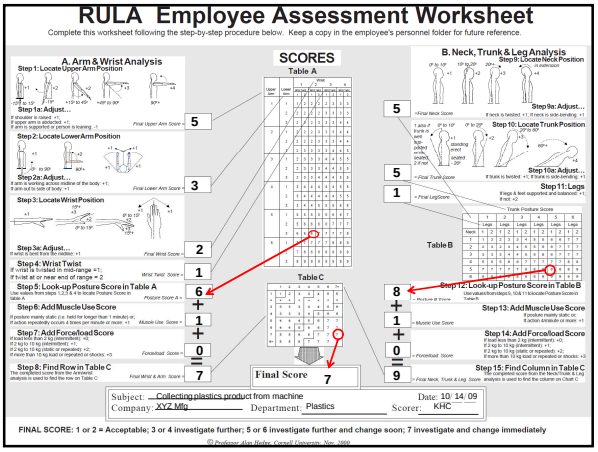

RULA (Rapid Upper Limb Assessment)

- **Action level 1 - RULA score 1-2: person is working in the best posture with no risk of injury from their work posture**
- **Action level 2 - RULA score 3-4: person is working in a posture that could present some risk of injury from their work posture. Score is most likely the result of one body part being in a deviated or awkward position. This should be investigated and corrected.**

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RULA (Rapid Upper Limb Assessment

- **Action level 3 - RULA score 5-6: person is working in a poor posture with a risk of injury from their work posture. Reasons need to be investigated and changed in the near future to prevent an injury**
- **Action level 4 - RULA score 7-8: person is working in the worst posture with an immediate risk of injury from their work posture. Reasons need to be investigated and changed immediately to prevent an injury**

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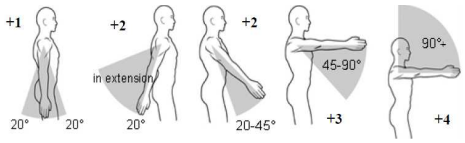
RULA (Rapid Upper Limb Assessment

- Limitations?
- Focuses a lot on posture
- A little more complicated to analyze



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On Line RULA Tool
http://www.rula.co.uk

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Plastic Product placement Example.xls

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Washington State Lifting Model

- Dr. Barbara Silverstein lead developer
- Easiest of Lifting assessment tools to use
- Less conservative in maximum lifting values than NIOSH tool
- Visual and easy to use with workers and supervisors
- Based on same science as the NIOSH tool
- Observational – non disruptive to the worker
- Reviews several risk factors – still a mono task tool though – has its limits

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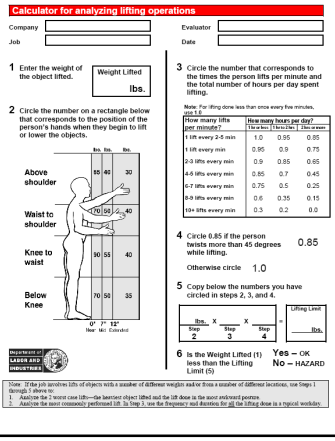

Calculator for analyzing lifting operations

Company | Evaluator
Job | Date

1 Enter the weight of the object lifted. Weight Lifted ____ lbs.

2 Circle the number on a rectangle below that corresponds to the position of the person's hands when they begin to lift or lower the objects.

	lbs.	lbs.	lbs.
Above shoulder	55	40	30
Waist to shoulder	70	55	40
Knee to waist	90	55	40
Below Knee	70	50	35

0° 7° 12° Near Mid Extended

3 Circle the number that corresponds to the times the person lifts per minute and the total number of hours per day spent lifting.

Note: For lifting done less than once every five minutes, use 0.6

How many lifts per minute?	How many hours per day? Up to 1hr.	1 hr. to 2 hrs.	2 hrs. to 8 hrs.
1 lift every 2-5 min	1.0	0.95	0.85
1 lift every min	0.95	0.9	0.75
2-3 lifts every min	0.9	0.85	0.65
4-5 lifts every min	0.85	0.7	0.45
6-7 lifts every min	0.75	0.5	0.25
8-9 lifts every min	0.6	0.35	0.15
10+ lifts every min	0.3	0.2	0.0

4 Circle 0.85 if the person twists more than 45 degrees while lifting. 0.85
Otherwise circle 1.0

5 Copy below the numbers you have circled in steps 2, 3, and 4.

lbs. (Step 2) X (Step 3) X (Step 4) = Lifting Limit ____ lbs.

6 Is the Weight Lifted (1) less than the Lifting Limit (5) Yes – OK No – HAZARD

Note: If the job involves lifts of objects with a number of different weights and/or from a number of different locations, use Steps 1 through 5 above to:
1. Analyze the 2 worst case lifts—the heaviest object lifted and the lift done in the most awkward posture.
2. Analyze the most commonly performed lift. In Step 1, use the frequency and duration for all the lifting done in a typical workday.

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Packaging and Palletizing

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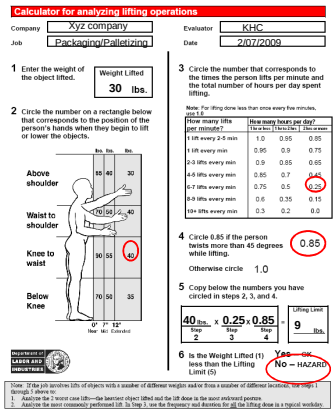

Calculator for analyzing lifting operations

Company: Xyz company | Evaluator: KHC
Job: Packaging/Palletizing | Date: 2/07/2009

1 Enter the weight of the object lifted. Weight Lifted: 30 lbs.

2 Circle the number on a rectangle below that corresponds to the position of the person's hands when they begin to lift or lower the objects.

	lbs.	lbs.	lbs.
Above shoulder	55	40	30
Waist to shoulder	70	55	40
Knee to waist	90	55	40
Below Knee	70	55	35

0° 7° 23°
Near Mid. Extended

3 Circle the number that corresponds to the times the person lifts per minute and the total number of hours per day spent lifting.

Note: For lifting done less than once every five minutes, use 1.0.

How many lifts per minute?	How many hours per day? 1 hr or less	1 hr to 2 hrs	2 hrs or more
1 lift every 2-5 min	1.0	0.95	0.85
1 lift every min	0.95	0.9	0.75
2-3 lifts every min	0.9	0.85	0.65
4-5 lifts every min	0.85	0.7	0.45
6-7 lifts every min	0.75	0.5	0.25
8-9 lifts every min	0.6	0.35	0.15
10+ lifts every min	0.3	0.2	0.0

4 Circle 0.85 if the person twists more than 45 degrees while lifting. 0.85
Otherwise circle 1.0

5 Copy below the numbers you have circled in steps 2, 3, and 4.

40 lbs. (Step 2) x 0.25 (Step 3) x 0.85 (Step 4) = Lifting Limit: 9 lbs.

6 Is the Weight Lifted (1) less than the Lifting Limit (5)? Yes – OK / No – HAZARD

Note: If the job involves lifts of objects with a number of different weights and/or from a number of different locations, use steps 1 through 5 above to:
1. Analyze the 3 worst case lifts—the heaviest object lifted and the lift done in the most awkward posture.
2. Analyze the most commonly performed lift. In Step 3, use the frequency and duration for all the lifting done in a typical workday.

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Washington State Interactive Tool

..\liftingcalc\ergo_worksheetIE.htm

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Possible Improvements to task:

- Reduce load weight
- Use Mechanical Assists such as overhead hoists.
- Reduce the horizontal distance of the load away from the body by removing barriers and obstacles that make access to the object difficult.
- Rotate workers to jobs with light or no manual handling.
- Reduce load height to between waist and shoulder level.

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NIOSH Revised Lifting Equation

- Originally published in 1981, revised in 1985
- Gold Standard for analysis of lifting tasks – addresses most of the risk factors
- More complex and cumbersome to use but yields good analysis
- Linked to human data on disc compression and anthropometry
- Uses very conservative factors

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Revised NIOSH Lifting Equation

RWL= LC x HM x VM x DM x AM x FM x CM

Where:

- LC= Load Constant = 51 lb
- HM = Horizontal Multiplier = (10/H)
- VM = Vertical Multiplier = 1-(.0075 | V-30|) where V= vertical height
- DM = Distance Multiplier = 0.82 + (1.8/D) where D=distance moved in vertical plane (difference between V at beginning of lift and V at end of lift)
- AM = Asymmetric Multiplier = 1-(0.0032A) where A is the angle of asymmetry
- FM = Frequency Multiplier from table values
- CM = Coupling Multiplier from table values

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REVISED NIOSH LIFTING EQUATION:

Purpose:

- Determine the Recommended Weight Limit (RWL).
- Compare the RWL to the actual weight to determine the Lifting Index (LI).
- Determine if corrective action is needed.
- The LI will be used by OSHA to determine ergonomic lifting violations.

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REVISED NIOSH LIFTING EQUATION

ASSUMPTIONS:

- The load is evenly distributed between hands.
- The load is lifted with two hands.
- The distance between the hands is 25 inches or less.
- A smooth, continuous lift is used.
- Both feet are on the ground.
- There is good footing.
- The environment is moderate.

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REVISED NIOSH LIFTING EQUATION

The Recommended Weight Limit (RWL) is the load that "nearly all health employees (90% of the adult population) can lift over a substantial period (i.e., up to 8 hours) without … increasing the risk of musculoskeletal disorders to the lower back."

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REVISED NIOSH LIFTING EQUATION:
Calculating the RWL

Step 1: Measure and record task variables.

Step 2: Apply multipliers to the variables.

Calculate the RWL at the

Origin

Destination

Step 3: Use the RWL to calculate the Lifting Index (LI).

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REVISED NIOSH LIFTING EQUATION
Step 1: Record the Variables

- **Load Weight (L)** = Weight of the load lifted in pounds
- **Horizontal Location (H)** = Distance of the hands from the midpoint between the ankles in inches (measure at origin & destination)
- **Vertical Location (V)** = Distance of the hands above the floor in inches (measure at origin & destination.
- **Vertical Travel Distance (D)** = Absolute value of the difference between the vertical location at the origin of the lift and at the destination of the lift.

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REVISED NIOSH LIFTING EQUATION
Step 1: Record the Variables

- **Asymmetry Angle (A)** = Angular measure of how far the object is displaced from the front (mid-sagittal plane) of the workers body at the beginning or the ending of the lift in degrees.
- **Lifting Frequency (F)** = Average number of lifts/minute in over fifteen minute time period.
- **Duration** = Classified as short (1 hour or less), moderate (1 to 2 hours), and long (2 to 8 hours).
- **Coupling** = Classified as Good, Fair or Poor

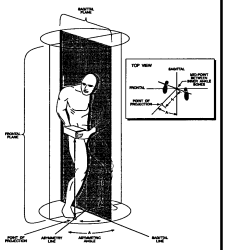

Figure 2 Graphic Representation of Angle of Asymmetry (A)

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Table 6
Hand-to-Container Coupling Classification

GOOD	FAIR	POOR
1. For containers of optimal design, such as some boxes, crates, etc., a "Good" hand-to-object coupling would be defined as handles or hand-hold cut-outs of optimal design [see notes 1 to 3 below].	1. For containers of optimal design, a "Fair" hand-to-object coupling would be defined as handles or hand-hold cut-outs of less than optimal design [see notes 1 to 4 below].	1. Containers of less than optimal design or loose parts or irregular objects that are bulky, hard to handle, or have sharp edges [see note 5 below].
2. For loose parts or irregular objects, which are not usually containerized, such as castings, stock, and supply materials, a "Good" hand-to-object coupling would be defined as a comfortable grip in which the hand can be easily wrapped around the object [see note 6 below].	2. For containers of optimal design with no handles or hand-hold cut-outs or for loose parts or irregular objects, a "Fair" hand-to-object coupling is defined as a grip in which the hand can be flexed about 90 degrees [see note 4 below].	2. Lifting non-rigid bags (i.e., bags that sag in the middle).

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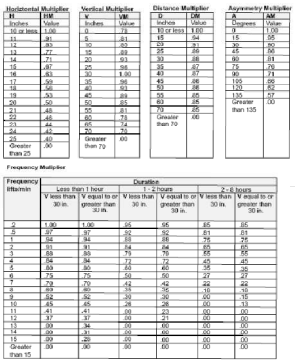
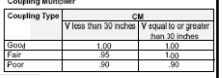
REVISED NIOSH LIFTING EQUATION
Step 2: Determine Multipliers from Tables



....Or calculate them if you want to.



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REVISED NIOSH LIFTING EQUATION
STEP 3 Calculate the RWL

Apply the RWL formula to determine the RWL.

Origin

RWL=LCxHMxVMxDMxAMxFMxCM = ____ lbs

Destination

RWL=LCxHMxVMxDMxAMxFMxCM = ____ lbs

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REVISED NIOSH LIFTING EQUATION
STEP 4: Compute Lifting Index (LI)

Origin

$$LI = \frac{\text{Object Weight (L)}}{\text{RWL}}$$

Destination

$$LI = \frac{\text{Object Weight (L)}}{\text{RWL}}$$

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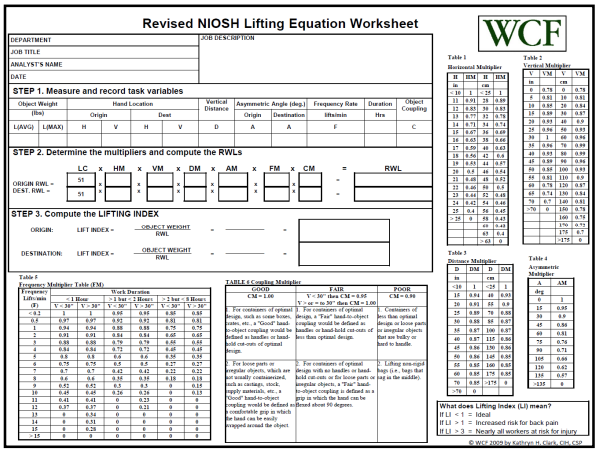
REVISED NIOSH LIFTING EQUATION
Lifting Index Results

- **Estimates the magnitude of physical stress**
  - **≤ 1, Ideal.**
  - **> 1, Increased risk for back pain.**
  - **> 3, Nearly all workers at risk for injury.**
- **Helps prioritize tasks for modification.**

WCF



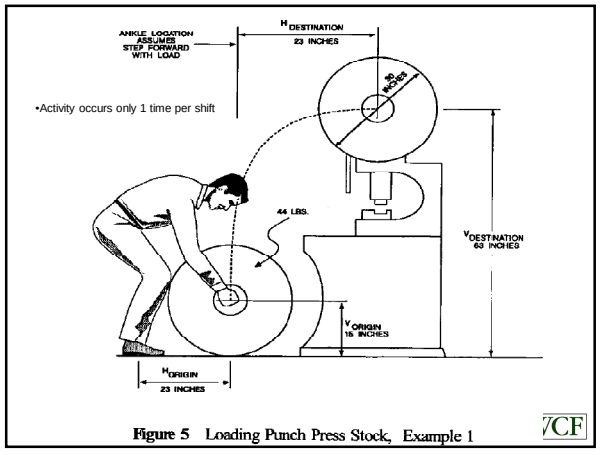
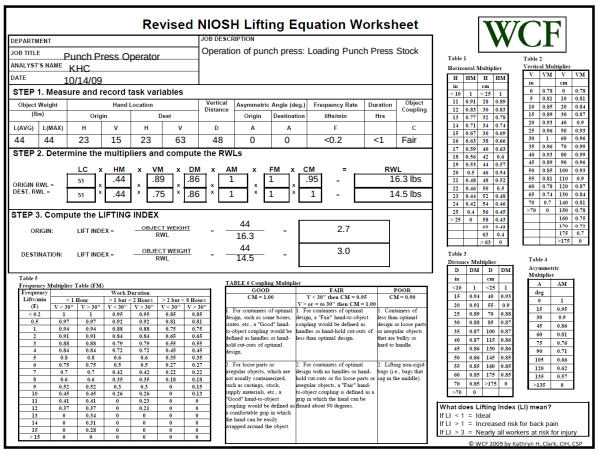


Figure 5 Loading Punch Press Stock, Example 1



Revised NIOSH Lifting Equation Worksheet

DEPARTMENT
JOB TITLE Punch Press Operator
ANALYST'S NAME KHC
DATE 10/14/09

JOB DESCRIPTION
Operation of punch press: Loading Punch Press Stock

STEP 1. Measure and record task variables

Object Weight (lbs)	Hand Location				Vertical Distance	Asymmetric Angle (deg.)		Frequency Rate	Duration	Object Coupling
	Origin		Dest			Origin	Destination	lifts/min	Hrs	
L(AVG)	L(MAX)	H	V	H	V	D	A	A	F		C
44	44	23	15	23	63	48	0	0	<0.2	<1	Fair

STEP 2. Determine the multipliers and compute the RWLs

	LC	x	HM	x	VM	x	DM	x	AM	x	FM	x	CM	=	RWL
ORIGIN RWL =	51	x	.44	x	.89	x	.86	x	1	x	1	x	.95	=	16.3 lbs
DEST. RWL =	51	x	.44	x	.75	x	.86	x	1	x	1	x	1	=	14.5 lbs

STEP 3. Compute the LIFTING INDEX

ORIGIN: LIFT INDEX = OBJECT WEIGHT / RWL = 44 / 16.3 = 2.7

DESTINATION: LIFT INDEX = OBJECT WEIGHT / RWL = 44 / 14.5 = 3.0

WCF

Table 1 Horizontal Multiplier

H (in)	HM (cm)	H (in)	HM (cm)
≤ 10	1	> 25	1
11	0.91	28	0.89
12	0.83	30	0.83
13	0.77	32	0.78
14	0.71	34	0.74
15	0.67	36	0.69
16	0.63	38	0.66
17	0.59	40	0.63
18	0.56	42	0.5
19	0.53	44	0.57
20	0.5	46	0.54
21	0.48	48	0.52
22	0.46	50	0.5
23	0.44	52	0.48
24	0.42	54	0.46
25	0.4	56	0.45
> 25	0	56	0.43
		60	0.42
		63	0.4
		> 63	0

Table 2 Vertical Multiplier

V (in)	VM (cm)	V (in)	VM (cm)
0	0.78	0	0.78
5	0.81	30	0.81
10	0.85	28	0.84
15	0.89	30	0.87
20	0.93	40	0.9
25	0.96	50	0.93
30	1	60	0.96
35	0.96	70	0.99
40	0.93	80	0.99
45	0.89	90	0.96
50	0.85	100	0.93
55	0.81	110	0.9
60	0.78	120	0.87
65	0.74	130	0.84
70	0.7	140	0.81
>70	0	150	0.78
		160	0.75
		170	0.72
		175	0.7
		>175	0

Table 3 Distance Multiplier

D (in)	DM (cm)	D (in)	DM (cm)
≤10	1	>25	1
15	0.94	40	0.93
20	0.91	55	0.9
25	0.89	70	0.88
30	0.88	85	0.87
35	0.87	100	0.87
40	0.87	115	0.86
45	0.86	130	0.86
50	0.86	145	0.85
55	0.85	160	0.85
60	0.85	175	0.85
70	0.85	>175	0
>70	0		

Table 4 Asymmetric Multiplier

A (deg.)	AM
0	1
15	0.95
30	0.9
45	0.86
60	0.81
75	0.76
90	0.71
105	0.66
120	0.62
135	0.57
>135	0

Table 5 Frequency Multiplier Table (FM)

Frequency Lifts/min (F)	Work Duration: ≤ 1 Hour V < 30"	≤ 1 Hour V ≥ 30"	> 1 but ≤ 2 Hours V < 30"	> 1 but ≤ 2 Hours V ≥ 30"	> 2 but ≤ 8 Hours: V < 30"	> 2 but ≤ 8 Hours: V ≥ 30"
≤ 0.2	1	1	0.95	0.95	0.85	0.85
0.5	0.97	0.97	0.92	0.92	0.81	0.81
1	0.94	0.94	0.88	0.88	0.75	0.75
2	0.91	0.91	0.84	0.84	0.65	0.65
3	0.88	0.88	0.79	0.79	0.55	0.55
4	0.84	0.84	0.72	0.72	0.45	0.45
5	0.8	0.8	0.6	0.6	0.35	0.35
6	0.75	0.75	0.5	0.5	0.27	0.27
7	0.7	0.7	0.42	0.42	0.22	0.22
8	0.6	0.6	0.35	0.35	0.18	0.18
9	0.52	0.52	0.3	0.3	0	0.15
10	0.45	0.45	0.26	0.26	0	0.13
11	0.41	0.41	0	0.23	0	0
12	0.37	0.37	0	0.21	0	0
13	0	0.34	0	0	0	0
14	0	0.31	0	0	0	0
15	0	0.28	0	0	0	0
>15	0	0	0	0	0	0

TABLE 6 Coupling Multiplier

GOOD CM = 1.00	FAIR V < 30" then CM = 0.95 V ≥ 30" then CM = 1.00	POOR CM = 0.90
1. For containers of optimal design, such as some boxes, crates, etc., a "Good" hand-to-object coupling would be defined as handles or hand-hold cut-outs of optimal design.	1. For containers of optimal design, a "Fair" hand-to-object coupling would be defined as handles or hand-hold cut-outs of less than optimal design.	1. Containers of less than optimal design or loose parts or irregular objects that are bulky or hard to handle.
2. For loose parts or irregular objects, which are not usually containerized, such as cartons, stock, supply materials, etc., a "Good" hand-to-object coupling would be defined as a comfortable grip in which the hand can be easily wrapped around the object.	2. For containers of optimal design with no handles or hand-hold cut-outs or for loose parts or irregular objects, a "Fair" hand-to-object coupling is defined as a grip in which the hand can be flexed about 90 degrees.	2. Lifting non-rigid bags (i.e., bags that sag in the middle).

What does Lifting Index (LI) mean?
If LI < 1 = Ideal
If LI > 1 = Increased risk for back pain
If LI > 3 = Nearly all workers at risk for injury

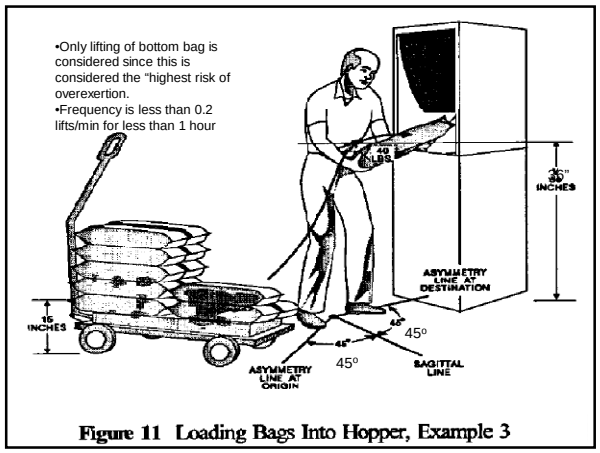
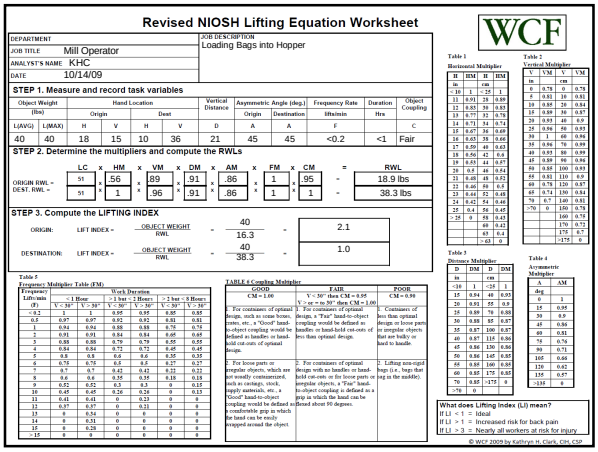


Figure 11 Loading Bags Into Hopper, Example 3



Revised NIOSH Lifting Equation Worksheet

DEPARTMENT
JOB TITLE Mill Operator
ANALYST'S NAME KHC
DATE 10/14/09

JOB DESCRIPTION
Loading Bags into Hopper

STEP 1. Measure and record task variables

Object Weight (lbs)	Hand Location				Vertical Distance	Asymmetric Angle (deg.)		Frequency Rate	Duration	Object Coupling
	Origin		Dest			Origin	Destination	lifts/min	Hrs	
L(AVG)	L(MAX)	H	V	H	V	D	A	A	F		C
40	40	18	15	10	36	21	45	45	<0.2	<1	Fair

STEP 2. Determine the multipliers and compute the RWLs

	LC	x	HM	x	VM	x	DM	x	AM	x	FM	x	CM	=	RWL
ORIGIN RWL =	51	x	.56	x	.89	x	.91	x	.86	x	1	x	.95	=	18.9 lbs
DEST. RWL =	51	x	1	x	.96	x	.91	x	.86	x	1	x	1	=	38.3 lbs

STEP 3. Compute the LIFTING INDEX

ORIGIN: LIFT INDEX = OBJECT WEIGHT / RWL = 40 / 16.3 = 2.1

DESTINATION: LIFT INDEX = OBJECT WEIGHT / RWL = 40 / 38.3 = 1.0

WCF

Table 1 Horizontal Multiplier

H (in)	HM (cm)	H (in)	HM (cm)
≤ 10	1	> 25	1
11	0.91	28	0.89
12	0.83	30	0.83
13	0.77	32	0.78
14	0.71	34	0.74
15	0.67	36	0.69
16	0.63	38	0.66
17	0.59	40	0.63
18	0.56	42	0.6
19	0.53	44	0.57
20	0.5	46	0.54
21	0.48	48	0.52
22	0.46	50	0.5
23	0.44	52	0.48
24	0.42	54	0.46
25	0.4	56	0.45
> 25	0	56	0.43
		60	0.42
		63	0.4
		> 63	0

Table 2 Vertical Multiplier

V (in)	VM (cm)	V (in)	VM (cm)
0	0.78	0	0.78
5	0.81	30	0.81
10	0.85	28	0.84
15	0.89	30	0.87
20	0.93	40	0.9
25	0.96	50	0.93
30	1	60	0.96
35	0.96	70	0.99
40	0.93	80	0.99
45	0.89	90	0.96
50	0.85	100	0.93
55	0.81	110	0.9
60	0.78	120	0.87
65	0.74	130	0.84
70	0.7	140	0.81
>70	0	150	0.78
		160	0.75
		170	0.72
		175	0.7
		>175	0

Table 3 Distance Multiplier

D (in)	DM (cm)	D (in)	DM (cm)
≤10	1	>25	1
15	0.94	40	0.93
20	0.91	55	0.9
25	0.89	70	0.88
30	0.88	85	0.87
35	0.87	100	0.87
40	0.87	115	0.86
45	0.86	130	0.86
50	0.86	145	0.85
55	0.85	160	0.85
60	0.85	175	0.85
70	0.85	>175	0
>70	0		

Table 4 Asymmetric Multiplier

A (deg.)	AM
0	1
15	0.95
30	0.9
45	0.86
60	0.81
75	0.76
90	0.71
105	0.66
120	0.62
135	0.57
>135	0

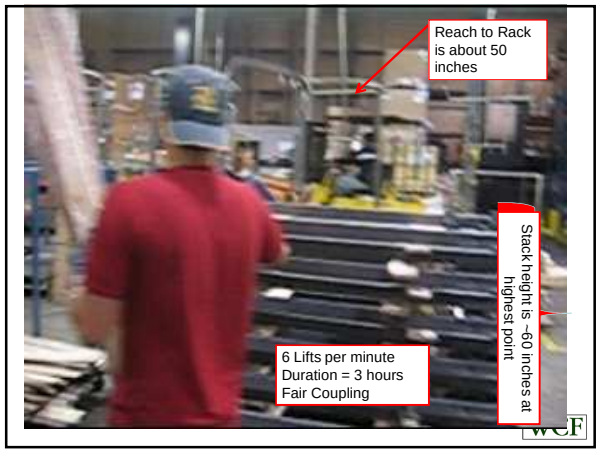
Table 5 Frequency Multiplier Table (FM)

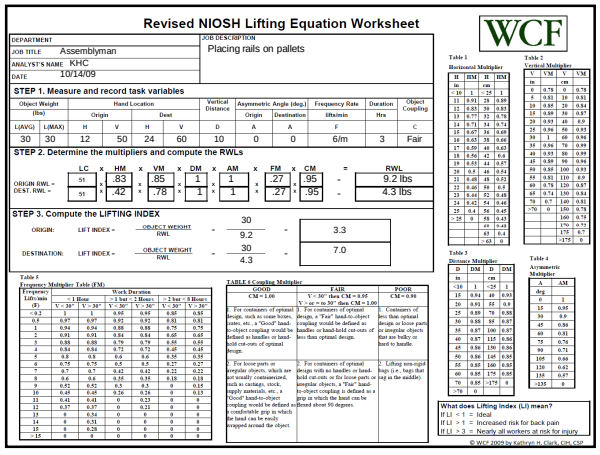
Frequency Lifts/min (F)	Work Duration: ≤ 1 Hour V < 30"	≤ 1 Hour V ≥ 30"	> 1 but ≤ 2 Hours V < 30"	> 1 but ≤ 2 Hours V ≥ 30"	> 2 but ≤ 8 Hours: V < 30"	> 2 but ≤ 8 Hours: V ≥ 30"
≤ 0.2	1	1	0.95	0.95	0.85	0.85
0.5	0.97	0.97	0.92	0.92	0.81	0.81
1	0.94	0.94	0.88	0.88	0.75	0.75
2	0.91	0.91	0.84	0.84	0.65	0.65
3	0.88	0.88	0.79	0.79	0.55	0.55
4	0.84	0.84	0.72	0.72	0.45	0.45
5	0.8	0.8	0.6	0.6	0.35	0.35
6	0.75	0.75	0.5	0.5	0.27	0.27
7	0.7	0.7	0.42	0.42	0.22	0.22
8	0.6	0.6	0.35	0.35	0.18	0.18
9	0.52	0.52	0.3	0.3	0	0.15
10	0.45	0.45	0.26	0.26	0	0.13
11	0.41	0.41	0	0.23	0	0
12	0.37	0.37	0	0.21	0	0
13	0	0.34	0	0	0	0
14	0	0.31	0	0	0	0
15	0	0.28	0	0	0	0
>15	0	0	0	0	0	0

TABLE 6 Coupling Multiplier

GOOD CM = 1.00	FAIR V < 30" then CM = 0.95 V ≥ 30" then CM = 1.00	POOR CM = 0.90
1. For containers of optimal design, such as some boxes, crates, etc., a "Good" hand-to-object coupling would be defined as handles or hand-hold cut-outs of optimal design.	1. For containers of optimal design, a "Fair" hand-to-object coupling would be defined as handles or hand-hold cut-outs of less than optimal design.	1. Containers of less than optimal design or loose parts or irregular objects that are bulky or hard to handle.
2. For loose parts or irregular objects, which are not usually containerized, such as cartons, stock, supply materials, etc., a "Good" hand-to-object coupling would be defined as a comfortable grip in which the hand can be easily wrapped around the object.	2. For containers of optimal design with no handles or hand-hold cut-outs or for loose parts or irregular objects, a "Fair" hand-to-object coupling is defined as a grip in which the hand can be flexed about 90 degrees.	2. Lifting non-rigid bags (i.e., bags that sag in the middle).

What does Lifting Index (LI) mean?
If LI < 1 = Ideal
If LI > 1 = Increased risk for back pain
If LI > 3 = Nearly all workers at risk for injury





Revised NIOSH Lifting Equation Worksheet

DEPARTMENT
JOB TITLE Assemblyman
ANALYST'S NAME KHC
DATE 10/14/09

JOB DESCRIPTION
Placing rails on pallets

STEP 1. Measure and record task variables

Object Weight (lbs)	Hand Location				Vertical Distance	Asymmetric Angle (deg.)		Frequency Rate	Duration	Object Coupling
	Origin		Dest			Origin	Destination	lifts/min	Hrs	
L(AVG)	L(MAX)	H	V	H	V	D	A	A	F		C
30	30	12	50	24	60	10	0	0	6/m	3	Fair

STEP 2. Determine the multipliers and compute the RWLs

	LC	x	HM	x	VM	x	DM	x	AM	x	FM	x	CM	=	RWL
ORIGIN RWL =	51	x	.83	x	.85	x	1	x	1	x	.27	x	.95	=	9.2 lbs
DEST. RWL =	51	x	.42	x	.78	x	1	x	1	x	.27	x	.95	=	4.3 lbs

STEP 3. Compute the LIFTING INDEX

ORIGIN: LIFT INDEX = OBJECT WEIGHT / RWL = 30 / 9.2 = 3.3

DESTINATION: LIFT INDEX = OBJECT WEIGHT / RWL = 30 / 4.3 = 7.0

WCF

Table 1 Horizontal Multiplier

H (in)	HM (cm)	H (in)	HM (cm)
≤ 10	1	> 25	1
11	0.91	28	0.89
12	0.83	30	0.83
13	0.77	32	0.78
14	0.71	34	0.74
15	0.67	36	0.69
16	0.63	38	0.66
17	0.59	40	0.63
18	0.56	42	0.6
19	0.53	44	0.57
20	0.5	46	0.54
21	0.48	48	0.52
22	0.46	50	0.5
23	0.44	52	0.48
24	0.42	54	0.46
25	0.4	56	0.45
> 25	0	56	0.43
		60	0.42
		63	0.4
		> 63	0

Table 2 Vertical Multiplier

V (in)	VM (cm)	V (in)	VM (cm)
0	0.78	0	0.78
5	0.81	30	0.81
10	0.85	28	0.84
15	0.89	30	0.87
20	0.93	40	0.9
25	0.96	50	0.93
30	1	60	0.96
35	0.96	70	0.99
40	0.93	80	0.99
45	0.89	90	0.96
50	0.85	100	0.93
55	0.81	110	0.9
60	0.78	120	0.87
65	0.74	130	0.84
70	0.7	140	0.81
>70	0	150	0.78
		160	0.75
		170	0.72
		175	0.7
		>175	0

Table 3 Distance Multiplier

D (in)	DM (cm)	D (in)	DM (cm)
≤10	1	>25	1
15	0.94	40	0.93
20	0.91	55	0.9
25	0.89	70	0.88
30	0.88	85	0.87
35	0.87	100	0.87
40	0.87	115	0.86
45	0.86	130	0.86
50	0.86	145	0.85
55	0.85	160	0.85
60	0.85	175	0.85
70	0.85	>175	0
>70	0		

Table 4 Asymmetric Multiplier

A (deg.)	AM
0	1
15	0.95
30	0.9
45	0.86
60	0.81
75	0.76
90	0.71
105	0.66
120	0.62
135	0.57
>135	0

Table 5 Frequency Multiplier Table (FM)

Frequency Lifts/min (F)	Work Duration: ≤ 1 Hour V < 30"	≤ 1 Hour V ≥ 30"	> 1 but ≤ 2 Hours V < 30"	> 1 but ≤ 2 Hours V ≥ 30"	> 2 but ≤ 8 Hours: V < 30"	> 2 but ≤ 8 Hours: V ≥ 30"
≤ 0.2	1	1	0.95	0.95	0.85	0.85
0.5	0.97	0.97	0.92	0.92	0.81	0.81
1	0.94	0.94	0.88	0.88	0.75	0.75
2	0.91	0.91	0.84	0.84	0.65	0.65
3	0.88	0.88	0.79	0.79	0.55	0.55
4	0.84	0.84	0.72	0.72	0.45	0.45
5	0.8	0.8	0.6	0.6	0.35	0.35
6	0.75	0.75	0.5	0.5	0.27	0.27
7	0.7	0.7	0.42	0.42	0.22	0.22
8	0.6	0.6	0.35	0.35	0.18	0.18
9	0.52	0.52	0.3	0.3	0	0.15
10	0.45	0.45	0.26	0.26	0	0.13
11	0.41	0.41	0	0.23	0	0
12	0.37	0.37	0	0.21	0	0
13	0	0.34	0	0	0	0
14	0	0.31	0	0	0	0
15	0	0.28	0	0	0	0
>15	0	0	0	0	0	0

TABLE 6 Coupling Multiplier

GOOD CM = 1.00	FAIR V < 30" then CM = 0.95 V ≥ 30" then CM = 1.00	POOR CM = 0.90
1. For containers of optimal design, such as some boxes, crates, etc., a "Good" hand-to-object coupling would be defined as handles or hand-hold cut-outs of optimal design.	1. For containers of optimal design, a "Fair" hand-to-object coupling would be defined as handles or hand-hold cut-outs of less than optimal design.	1. Containers of less than optimal design or loose parts or irregular objects that are bulky or hard to handle.
2. For loose parts or irregular objects, which are not usually containerized, such as cartons, stock, supply materials, etc., a "Good" hand-to-object coupling would be defined as a comfortable grip in which the hand can be easily wrapped around the object.	2. For containers of optimal design with no handles or hand-hold cut-outs or for loose parts or irregular objects, a "Fair" hand-to-object coupling is defined as a grip in which the hand can be flexed about 90 degrees.	2. Lifting non-rigid bags (i.e., bags that sag in the middle).

What does Lifting Index (LI) mean?
If LI < 1 = Ideal
If LI > 1 = Increased risk for back pain
If LI > 3 = Nearly all workers at risk for injury

REVISED NIOSH LIFTING EQUATION
Lifting Index Results

- Estimates the magnitude of physical stress
  - ≤ 1, Ideal.
  - > 1, Increased risk for back pain.
  - > 3, Nearly all workers at risk for injury.
- Helps prioritize tasks for modification.

WCF

Problems:

- The lifting equation doesn't account for carrying the object as is done in this task.
- Video is at an angle that makes it difficult to measure distances. Take video from all angles to ensure accurate measurement.
- Measurements have to be taken which will be disruptive to work. Use reference measurements when possible for items that will be included in the video.
- One of the times the worker twists when placing the item but the other times he does not (inconsistency in task).

WCF

University of Southern Florida

NIOSH Lifting Equation Excel Tool

NIOSHLift30.xls

WCF

Practical Exercises

NIOSH Lifting Equation

WCF

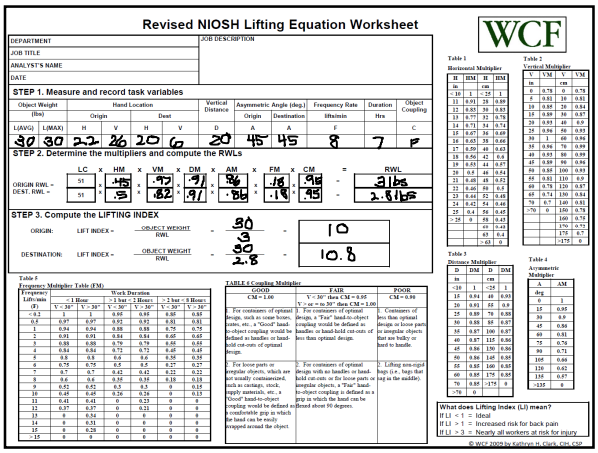
Packaging and Palletizing

WCF

Palletizing

- Origin H = 22, Destination H = 20
- Origin V = 26, Destination V = 6
- Origin A = 45, Destination A = 45
- Frequency = 8 lifts/min, 6 hours/day
- Coupling = fair

WCF



Revised NIOSH Lifting Equation Worksheet

DEPARTMENT
JOB TITLE
ANALYST'S NAME
DATE
JOB DESCRIPTION

STEP 1. Measure and record task variables

Object Weight (lbs)	Hand Location				Vertical Distance	Asymmetric Angle (deg.)		Frequency Rate	Duration	Object Coupling
	Origin		Dest			Origin	Destination	lifts/min	Hrs	
L(AVG)	H	V	H	V	D	A	A	F		C
30	30	22	26	20	20	45	45	8	7	P

STEP 2. Determine the multipliers and compute the RWLs

	LC	x	HM	x	VM	x	DM	x	AM	x	FM	x	CM	=	RWL
ORIGIN RWL =	51	x	.45	x	.97	x	.91	x	.86	x	.16	x	.95	=	3.186
DEST. RWL =	51	x	.51	x	.82	x	.91	x	.86	x	.19	x	.95	=	2.816

STEP 3. Compute the LIFTING INDEX

ORIGIN:	LIFT INDEX =	OBJECT WEIGHT / RWL	30 / 3	=	10
DESTINATION:	LIFT INDEX =	OBJECT WEIGHT / RWL	30 / 2.8	=	10.8

WCF

Table 1 Horizontal Multiplier

H	HM	H	HM
in		cm	
≤ 10	1	≤ 25	1
11	0.91	28	0.89
12	0.83	30	0.83
13	0.77	33	0.78
14	0.71	34	0.74
15	0.67	36	0.69
16	0.63	39	0.66
17	0.59	40	0.63
18	0.56	42	0.6
19	0.53	44	0.57
20	0.5	46	0.54
21	0.48	48	0.52
22	0.46	50	0.5
23	0.44	52	0.48
24	0.42	54	0.46
25	0.4	56	0.45
> 25	0	58	0.43
		60	0.42
		63	0.4
		> 63	0

Table 2 Vertical Multiplier

V	VM	V	VM
in		cm	
0	0.78	0	0.78
5	0.81	10	0.81
10	0.85	25	0.84
15	0.89	30	0.87
20	0.93	40	0.9
25	0.96	50	0.93
30	1	60	0.96
35	0.96	70	0.99
40	0.93	80	0.99
45	0.89	90	0.96
50	0.85	100	0.93
55	0.81	110	0.9
60	0.78	120	0.87
65	0.74	130	0.84
70	0.7	140	0.81
≥70	0	150	0.78
		160	0.75
		170	0.72
		175	0.7
		≥175	0

Table 3 Distance Multiplier

D	DM	D	DM
in		cm	
≤10	1	≤25	1
15	0.91	40	0.93
20	0.91	55	0.9
25	0.89	70	0.88
30	0.88	80	0.87
35	0.87	100	0.87
40	0.87	115	0.86
45	0.86	130	0.86
50	0.86	145	0.85
55	0.85	160	0.85
60	0.85	175	0.85
70	0.85	≥175	0
≥70	0		

Table 4 Asymmetric Multiplier

A	AM
deg	
0	1
15	0.95
30	0.9
45	0.86
60	0.81
75	0.76
90	0.71
105	0.66
120	0.62
135	0.57
≥135	0

Table 5 Frequency Multiplier Table (FM)

Frequency Lifts/min (F)	Work Duration					
	≤1 Hour		>1 but ≤2 Hours		>2 but ≤8 Hours	
	V < 30"	V ≥ 30"	V < 30"	V ≥ 30"	V < 30"	V ≥ 30"
≤ 0.2	1	1	0.95	0.95	0.85	0.85
0.5	0.97	0.97	0.92	0.92	0.81	0.81
1	0.94	0.94	0.88	0.88	0.75	0.75
2	0.91	0.91	0.84	0.84	0.65	0.65
3	0.88	0.88	0.79	0.79	0.55	0.55
4	0.84	0.84	0.72	0.72	0.45	0.45
5	0.8	0.8	0.6	0.6	0.35	0.35
6	0.75	0.75	0.5	0.5	0.27	0.27
7	0.7	0.7	0.42	0.42	0.22	0.22
8	0.6	0.6	0.35	0.35	0.18	0.18
9	0.52	0.52	0.3	0.3	0	0.15
10	0.45	0.45	0.26	0.26	0	0.13
11	0.41	0.41	0	0.23	0	0
12	0.37	0.37	0	0.21	0	0
13	0	0.34	0	0	0	0
14	0	0.31	0	0	0	0
15	0	0.28	0	0	0	0
> 15	0	0	0	0	0	0

TABLE 6 Coupling Multiplier

GOOD	FAIR	POOR
CM = 1.00	V < 30" then CM = 0.95 V ≥ or = to 30" then CM = 1.00	CM = 0.90
1. For containers of optimal design, such as some boxes, crates, etc., a "Good" hand-to-object coupling would be defined as handles or hand-hold cut-outs of optimal design.	1. For containers of optimal design, a "Fair" hand-to-object coupling would be defined as handles or hand-hold cut-outs of less than optimal design.	1. Containers of less than optimal design or loose parts or irregular objects that are bulky or hard to handle.
2. For loose parts or irregular objects, which are not usually containerized, such as cartons, stock, supply materials, etc., a "Good" hand-to-object coupling would be defined as a comfortable grip in which the hand can be wrapped around the object	2. For containers of optimal design with no handles or hand-hold cut-outs or for loose parts or irregular objects, a "Fair" hand-to-object coupling is defined as a grip in which the hand can be flexed about 90 degrees.	2. Lifting non-rigid bags (i.e., bags that sag in the middle)

What does Lifting Index (LI) mean?
If LI < 1 = Ideal
If LI > 1 = Increased risk for back pain
If LI > 3 = Nearly all workers at risk for injury

Free Tools for Palm based PDAs

- www.pocketIH.com
  - HAL
  - Snook Tables
  - NIOSH Revised Lifting Equation (Trial only – shareware costs $15)

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Free Ergonomic Tools

University of South Florida:

http://personal.health.usf.edu/tbernard/ergotools/index.html

Washington State:

http://www.lni.wa.gov/Safety/Topics/Ergonomics/ServicesResources/Tools/default.asp

OSHA:

http://www.osha.gov/SLTC/ergonomics/analysis_tools.html

WCF

Free Ergonomic Tools

NIOSH:

http://www.cdc.gov/niosh/topics/ergonomics/

Osmond Group RULA Calculator:

http://www.rula.co.uk/

Cornell University:

http://ergo.human.cornell.edu/default.htm

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Great Ergonomics Tools at a Price:

Ergoweb

www.ergoweb.com

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Job Assessment

- Prioritize efforts: Look at injury producing jobs or jobs identified through checklists
- Analyze the selected jobs using appropriate risk assessment tools
- Look for the simplest solutions first
- Incremental improvement is good
- There are no silver bullets

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Finding Solutions

- Changing the task, not the worker is preferable
- Good solutions may increase productivity
- Consult catalogs for better tools and material handling aids
- Try things out

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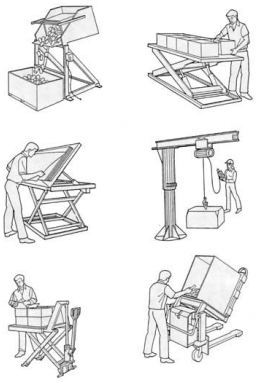

Success Stories

- AT&T Global: Workstation Improvements, training and conveyor system changes produced a reduction in workers compensation costs of $1.48 Million from 1990-94
- 3M: Implemented a full scale WMSD prevention program and saw a 22% decrease in OSHA recordable cases and a 58% fall in lost time cases
- OSHA/Nursing Homes Project: Implemented a model WMSD reduction program. One facilities WC costs went from $1.5M to $770K, another went from $750K to $184K.

Source: Ergoweb 2003

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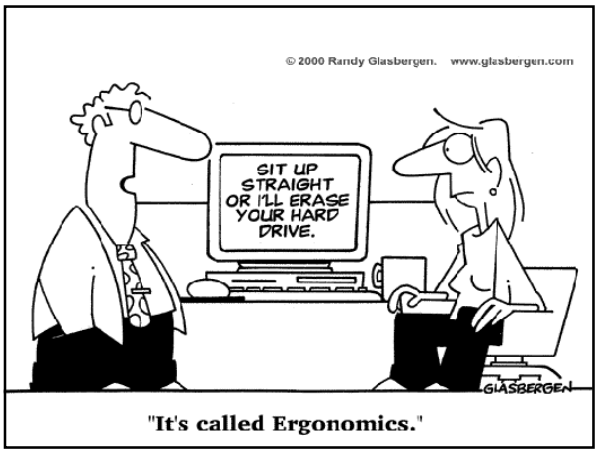

"It's called Ergonomics."

Questions

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